E-16-V95

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Sent: Friday, February 13, 2004 10:23 AM
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E-16-V95 #3

Combustion Instability and Blowout Characteristics of Fuel Flexible Gas Turbine Combustors

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SCIES Project 03-01-SR111

Project Awarded July, 1 2003
Total Contract Value $376,722

Gas Turbine Need

- *Need:* Gas turbines with sufficient flexibility to cleanly and efficiently combust a wide range of fuels, particularly coal-derived gases
  - *Problem:* Inherent variability in composition and heating value of coal-derived and other alternative fuels provides significant barriers towards their usage
- *Need:* Combustion systems that can stably operate over a wide turndown range
  - *Problem*: Combustion instabilities and blowout have been key problems encountered by gas turbines, severely limiting their turndown, restricting maximum power output, increasing unplanned outages, and increasing maintenance costs.

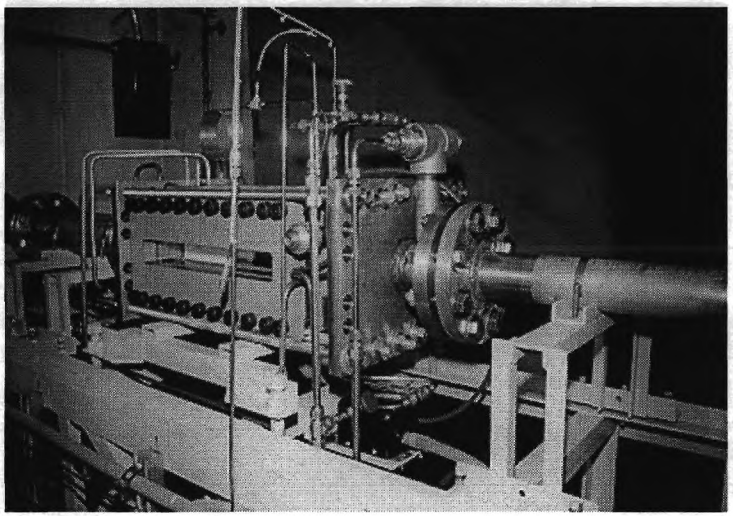
Project Objectives

- Task 1 – Develop fuel specifications test matrix
  - Objective: Determine representative range of potential fuel compositions
- Task 2 - Analyze Static Stability Characteristics
  - Objective: Reducing blowout events, thereby increasing turbine availability
- Task 3 - Analyze Dynamic Stability Characteristics
  - Objective: Minimizing combustion dynamics, thereby increasing machine life and availability.

Project Approach

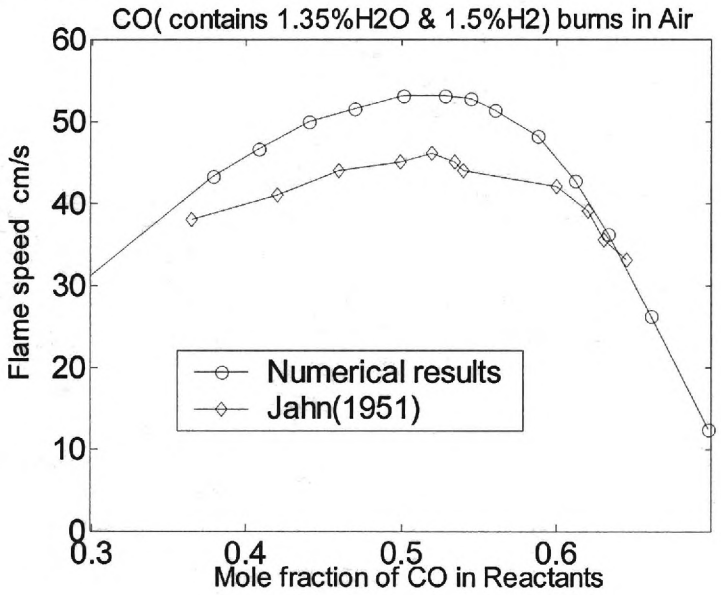
- Task 1:
  - Determine fuel compositions in various IGCC, landfill, process gas plants
  - Determine test conditions of other ongoing efforts
  - Statistical design of experiments
  - Obtain input from industry
- Tasks 2 and 3
  - Characterize fuel composition, dynamics effects upon blowout (Task 2) and pulsations amplitude (Task 3) conditions
  - Correlate results with chemical kinetics calculations
  - Communication with industrial partners

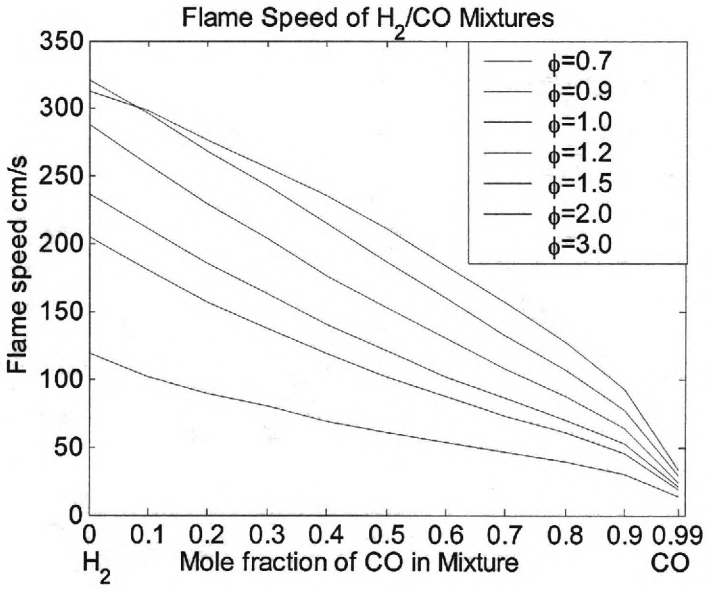
Combustor Testbed



Recent Results

- Performing Chemkin studies to analyze fuel composition effects on:
  - flame speed
  - stretch sensitivity
  - blowoff residence times
- Results are being used to design experimental parameter space





Project Summary

- Program benefits the gas turbine and energy industry by:
  - removing barriers toward the usage of coal derived gaseous fuels through improved understanding of their combustion characteristics
  - improving modeling tools needed by OEM's to design fuel-flexible combustion systems.

- Benefits will improve air quality and increase the energy security of the USA, by allowing power plants to operate:
  - efficiently
  - with minimal pollution
  - using a variety of domestic fuel sources